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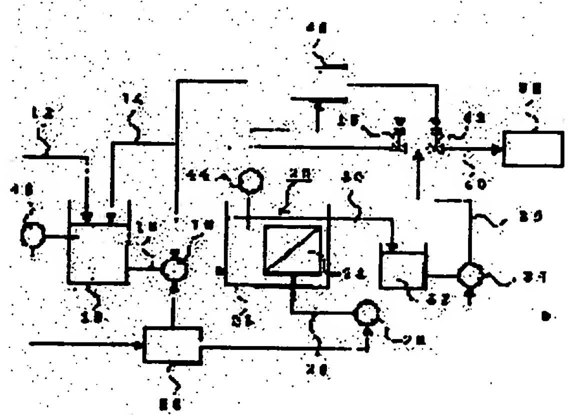
(54) CONCENTRATION METHOD FOR SLUDGE

(57)Abstract:

PROBLEM TO BE SOLVED: To stably keep the load to a membrane separator to set the concentration of concentrated sludge discharged to the outside of a system at a constant target value.

SOLUTION: In the concentration method wherein sludge supplied from a sludge supply tank 10 is guided to the membrane separator 20 to be subjected to membrane separation treatment to be separated into a permeated liquid and concentrated sludge, circulating operation for returning the concentrated sludge discharged from the membrane separator 20 to the sludge supply tank 10 and discharge treatment for sending all of the concentrated sludge out of the system are alternately repeated by the changeover control of changeover valves 15 and 42 based on the detection value of a sludge concentrator 44.



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CLAIMS

[Claim(s)]
[Claim 1] While returning some concentration sludge [at least] which is the concentration approach of the sludge which carries out membrane-separation processing, and which leads the supply sludge from a sludge supply tub to a membrane separation device, and is divided into transparency liquid and concentration sludge, and is discharged from said membrane separation device to said sludge supply tub Carry out circulation operation which sends out the remainder out of a system, and the whole quantity of the concentration sludge discharged from a membrane separation device when the sludge concentration of said concentration sludge rises and a upper limit is reached is changed to discharge operation sent out out of a system as a result of this circulation operation. The concentration approach of the sludge characterized by changing to said circulation operation when the sludge concentration of said concentration sludge descends and a lower limit is reached as a result of this discharge operation, and repeating circulation operation and discharge operation by turns.
[Claim 2] The concentration approach of the sludge according to claim 1 characterized by holding the flow rate of supply sludge and transparency liquid uniformly in said circulation operation and discharge operation, and performing accommodation of throughput based on fluctuation of the sludge concentration of original sludge by the intermittent running of said membrane separation device.
[Claim 3] The concentration approach of the sludge according to claim 1 or 2 characterized by adjusting the setting flow rate of supply sludge so that the operation-time ratio of said circulation operation and discharge operation may be set to 1 / 10 - 1/2.
[Claim 4] While returning some concentration sludge [at least] which is the concentration approach of the sludge which carries out membrane-separation processing, and which leads the supply sludge from a sludge supply tub to a membrane separation device, and is divided into transparency liquid and concentration sludge, and is discharged from said membrane separation device to said sludge supply tub Carry out circulation operation which sends out the remainder out of a system, and the whole quantity of the concentration sludge discharged from a membrane separation device when the sludge concentration of said concentration sludge rises and the 1st upper limit is reached is changed to discharge operation sent out out of a system as a result of this circulation operation. When the sludge concentration of said concentration sludge descends and a lower limit is reached as a result of this discharge operation, while changing to said circulation operation and repeating circulation operation and discharge operation by turns Suspending membrane-separation processing in a membrane separation device, when the sludge concentration of said concentration sludge does not descend but the sludge concentration of concentration sludge reaches the 2nd upper limit [still high concentration / upper limit / said / 1st] also by said discharge operation The concentration approach of the sludge characterized by carrying out extrusion operation which is made to discharge the concentration sludge of the amount equivalent to the supply sludge supplied from a membrane separation device, and sends it out out of a system.
[Claim 5] Said membrane separation device is the concentration approach of the sludge according to claim 1 to 4 characterized by providing the separation tub, the membrane module immersed in the concentration sludge in this separation tub, and a discharge means of concentration sludge to hold the oil level of concentration sludge uniformly.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the concentration approach of the sludge which is applied to the concentration approach of sludge, especially carries out membrane-separation processing of the sludge, and is divided into transparency liquid and concentration sludge.
[0002]
[Description of the Prior Art] In the field of waste water treatment or water purification processing, carrying out membrane-separation processing of the sludge generated by the biology target or physicochemical processing, and separating into transparency liquid and concentration sludge is performed. The immersing [in the separation tub which filled concentration sludge / the membrane module]-as membrane separation device for concentration thing is known. Generally in this immersion-type membrane separation device, operation which holds uniformly the flow rate of the transparency liquid attracted from a membrane module is performed, supplying the original sludge of a quantum to a separation tub continuously. It was operation which becomes fixed [the amount of the concentration sludge overflowed and discharged] as difference of original sludge and transparency liquid from a separation tub. The sludge concentration of concentration sludge becomes settled according to the concentration rate which is the ratio of the amount of original sludge, and the amount of concentration sludge. Therefore, in operation with the above fixed concentration rates, when the sludge concentration of original sludge is changed, the sludge concentration of concentration sludge is also changed proportionally.
[0003]
[Problem(s) to be Solved by the Invention] Although stable processing is possible from a quantitative viewpoint, when the sludge concentration of original sludge becomes high according to a certain cause according to the above-mentioned concentration approach, the sludge concentration of concentration sludge also becomes high, the blinding of a filtration membrane etc. is induced, and the fault on the operation of a membrane separation device is caused. Moreover, although concentration sludge received processing of dehydration, solar drying, incineration, etc. as latter-part processing, when the sludge concentration of concentration sludge was changed, the load of latter-part processing and operation became unstable, and there was a trouble of reducing the processing engine performance and effectiveness.
[0004] In order to solve such a trouble, the sludge concentration of concentration sludge is measured and it is possible to carry out feedback control of the flow rate of original sludge or transparency liquid so that the sludge concentration of concentration sludge may serve as desired value based on the measurement result. However, when fluctuation of the sludge concentration of original sludge is large, the load of a membrane separation device will also be followed in footsteps and changed, and such an approach causes the instability of operation, while the equipment configuration for realizing feedback control is complicated and becomes expensive. Without improving the trouble of the above-mentioned conventional technique and performing feedback control complicated even when fluctuation of the sludge concentration of original sludge is large, the load of a membrane separation device is maintained to stability, and the purpose of this invention is to offer the

concentration approach of the sludge which can make sludge concentration of the concentration sludge finally discharged out of a system fixed desired value.

[0005]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the concentration approach of the sludge concerning this invention While returning some concentration sludge [at least] which is the concentration approach of the sludge which carries out membrane-separation processing, and which leads the supply sludge from a sludge supply tub to a membrane separation device, and is divided into transparency liquid and concentration sludge, and is discharged from said membrane separation device to said sludge supply tub Carry out circulation operation which sends out the remainder out of a system, and the whole quantity of the concentration sludge discharged from a membrane separation device when the sludge concentration of said concentration sludge rises and a upper limit is reached is changed to discharge operation sent out out of a system as a result of this circulation operation. As a result of this discharge operation, when the sludge concentration of said concentration sludge descends and a lower limit is reached, it changes to said circulation operation, and it is characterized by repeating circulation operation and discharge operation by turns. In addition, in this invention, "when the value is approached, and it becomes the value exactly", "he shall understand" the vocabulary "the time when reaching a upper limit (lower limit)" to "all when exceeding the value". ["the time of reaching"]

[0006] Moreover, it is characterized by for the concentration approach of the sludge concerning this invention holding the flow rate of supply sludge and transparency liquid uniformly in said circulation operation and discharge operation, and performing accommodation of the throughput of original sludge by the intermittent running of said membrane separation device in the above-mentioned configuration. Moreover, the concentration approach of the sludge concerning this invention is characterized by adjusting the setting flow rate of supply sludge so that the operation-time ratio of said circulation operation and discharge operation may be set to 1 / 10 - 1/2 in the above-mentioned configuration.

[0007] Moreover, the concentration approach of the sludge concerning this invention is characterized by said membrane separation device possessing the separation tub, the membrane module immersed in the concentration sludge in this separation tub, and a discharge means of concentration sludge to hold the oil level of concentration sludge uniformly in the above-mentioned configuration.

[0008]

[Embodiment of the Invention] Drawing 1 is an equipment schematic diagram for enforcing the concentration approach of the sludge concerning this invention. In drawing 1 , the original sludge which is a concentration object flows into the sludge supply tub 10 from a duct 12. Moreover, concentration sludge is intermittently returned to this sludge supply tub 10 so that it may mention later from a duct 14. The sludge supply tub 10 is connected with a membrane separation device 20 by the duct 16, and the sludge in the sludge supply tub 10 is supplied to a membrane separation device 20 by the feed pump 18 prepared in the middle of the duct 16. In this invention, the sludge supplied to a membrane separation device 20 from such a sludge supply tub 10 is defined as supply sludge, and it distinguishes from said Hara sludge. A membrane separation device 20 mainly consists of a separation tub 22 and a membrane module 24 immersed in the concentration sludge in this separation tub 22. A duct 26 is connected to secondary [of a membrane module 24], and with the suction pump 28 prepared in this duct 26, the transparency liquid which penetrated the filtration membrane of a membrane module 24 is extracted from a duct 26, and is discharged out of a system. Moreover, as for the concentration sludge in the separation tub 22 condensed by membrane separation, an overflowed part is discharged from a duct 30, the oil level being held uniformly.

[0009] The micro filter or ultrafiltration membrane formed with the organic material or the ceramic ingredient as film material of a membrane module 24 is used. The membrane module of a rotation flat film type it was made for the hollow fiber of an immersion type and a flat film to make rotate a disc-like flat film desirable especially as a form of a membrane module 24 is convenient to concentration of sludge. However, the membrane separation device concerning this invention is applicable also to the thing using the membrane module of not only a thing but a juxtaductal type using an above-mentioned immersion-type membrane module.

[0010] After the concentration sludge discharged from the duct 30 goes via ****** 32, it is sent out from a duct 36 with an eductor pump 34 to either said sludge supply tub 10 or the sludge tank 38. That is, the duct 36 has branched to the duct 14 for circulation, and the duct 40 for discharge, a selector valve 15 is formed in a duct 14, and the selector valve 42 is formed in the duct 40. By operating this selector valve 15 and selector valve 42, the concentration sludge from a duct 36 is returned to the sludge supply tub 10 through a duct 14, or is discharged by the sludge tank 38 through a duct 42. Actuation of a selector valve 15 and a selector valve 42 is controlled by the controller 46 which incorporates a sludge densitometer's 44 detecting signal arranged in said separation tub 22. In addition, this controller 46 is equipped with the function which outputs the signal which adjusts the setting flow rate of supply sludge to a feed pump 18 according to the operation situation of a membrane separation device 20. Moreover, a level gage 48 is arranged in the sludge supply tub 10, and operation of a feed pump 18, a suction pump 28, and an eductor pump 34 and a halt are controlled by the controller 50 which incorporated the detecting signal of this level gage 48. In addition, the oil level of the concentration sludge in the separation tub 22 is not restricted to the approach by the overflow described above as a discharge means of the concentration sludge held uniformly. You may make it control the amount of drawing of the concentration sludge by the eductor pump 34 so that the indicated value of the level gage established in the separation tub 22 becomes fixed.

[0011] In the above-mentioned configuration, it flows into the sludge supply tub 10 continuously [original sludge] or intermittently from a duct 12. Moreover, concentration sludge flows into the sludge supply tub 10 intermittently from a duct 14. These original sludge and concentration sludge are mixed within the sludge supply tub 10, and the supply sludge adjusted to concentration with sludge concentration comparatively higher than original sludge is supplied to a membrane separation device 20. In a membrane separation device 20, operation which holds uniformly the flow rate of the transparency liquid attracted from the flow rate and membrane module 24 of supply sludge which are supplied is carried out. Consequently, the flow rate of the concentration sludge which overflows the separation tub 22 and is discharged is also held uniformly. In addition, the sludge concentration of the concentration sludge in the separation tub 22 is detected by the sludge densitometer 44 at intervals of suitable continuous or control, and the detecting signal is transmitted to a controller 46.

[0012] Suppose that the selector valve 15 was made open, the selector valve 42 was made close, and circulation operation which returns the whole quantity of the concentration sludge discharged from the separation tub 22 to the sludge supply tub 10 was carried out in the above-mentioned operation. As a result of this circulation operation, the concentration of supply sludge rises gradually and the sludge concentration of the concentration sludge in the separation tub 22 also rises gradually along with it. If the sludge concentration of the concentration sludge detected by the sludge densitometer 44 reaches a upper limit, the controller 46 which received the signal sends a change signal, and a selector valve 15 will be made close and it will make a selector valve 42 open. Consequently, it changes to discharge operation which sends out the whole quantity of the concentration sludge discharged from the separation tub 22 to the sludge tank 40, and is discharged out of a system. As a result of this discharge operation, it dilutes with the original sludge with which sludge with the comparatively high sludge concentration in the sludge supply tub 10 flows from a duct 12, and the concentration of supply sludge descends gradually and the sludge concentration of the concentration sludge in the separation tub 22 also descends gradually along with it. If the sludge concentration of the concentration sludge detected by the sludge densitometer 44 reaches a lower limit, a controller 46 will send a change signal and will change it to circulation operation. Henceforth, operation which repeats above-mentioned circulation operation and above-mentioned discharge operation by turns is continued. Under the present circumstances, the sludge concentration of the concentration sludge discharged out of a system is maintainable to the value by which within the limits of a upper limit and a lower limit was stabilized by making the sludge concentration of concentration sludge aiming at a setup of the upper limit in a controller 46, and a lower limit approach. And since each flow rate of supply sludge in the meantime, transparency liquid, and concentration sludge is held uniformly, the simplification and stability of operation can be aimed at. In addition, by the above-mentioned operation, the flow Q 1 of the flowing original sludge and the sum total flow Q 2 of transparency liquid and concentration sludge discharged out of a system serve as imbalance in each time zone. Therefore, in this

invention, flow Q 2 is set as oversized, and it is desirable to absorb amount of imbalance = at this time (flow Q 2-flow Q 1) (x time amount) by the intermittent running of a membrane separation device. That is, in drawing 1 , to the flow Q 1 of the original sludge which flows from a duct 12, the flow rate of supply sludge is set up greatly enough, and it operates so that the sum total flow Q 2 of transparency liquid and concentration sludge discharged out of a system may turn into ** and the flow Q 2> flow Q 1. Consequently, the sludge oil level of the sludge supply tub 10 falls gradually. A level gage 48 detects the lower limit of a sludge oil level, and operation of a feed pump 18, a suction pump 28, and an eductor pump 34 is stopped with a controller 50 based on the signal. If a sludge oil level does ** recovery of and a level gage 48 detects the upper limit of a sludge oil level when original sludge flows during the shutdown of this membrane separation device at ** sludge supply tub 10, a feed pump 18, a suction pump 28, and an eductor pump 34 will start a controller 50, and it will resume membrane-separation processing.

[0013] Next, the mass balance of various model cases is explained. Drawing 2 is the mass-balance Fig. of the 1st model case. The original sludge whose sludge concentration is 1.0% flows continuously by 3/hr the flow rate of 100m for 24 hours per day, and drawing 2 (b) shows the basic mass balance in the case of carrying out membrane-separation processing of this original sludge continuously, and obtaining the concentration sludge whose sludge concentration is 4.0%. In this case, as a result of condensing original sludge 4 times, the flow rate of concentration sludge and transparency liquid serves as 25m3/hr and 75m3/hr, respectively. Drawing 2 (b) illustrates the mass balance at the time of enforcing the approach which requires original sludge for this invention with (b) when the same. In this example, the flow rate of the supply sludge from the sludge supply tub 10 is made into 120m3/hr with enough more original sludge than a flow rate, and rather than the flow rate of the transparency liquid in the above-mentioned basic mass balance, the flow rate of transparency liquid is also set as many 80m3/hr, and is operated. Consequently, the flow rate of the concentration sludge discharged from a membrane separation device serves as 40m3/hr, and a concentration rate serves as 3 times as many operation as this. In order to obtain the concentration sludge whose sludge concentration is 4.0% according to this concentration rate, it is necessary to adjust the sludge concentration of supply sludge to 4 / 3= 1.33% higher enough than original sludge. Therefore, the change of circulation operation of concentration sludge and discharge operation is performed.

[0014] In actual control, if the upper limit of the sludge concentration of concentration sludge is made 4.1%, a lower limit is made into 3.9% and the sludge concentration of concentration sludge reaches to 4.1%, it will change from circulation operation to discharge operation. Moreover, as a result of discharge operation, if the sludge concentration of concentration sludge reaches to 3.9%, it will change to circulation operation. While converging the sludge concentration of supply sludge to 1.33% inevitably by repeating change control of this circulation operation and discharge operation, the sludge concentration of the concentration sludge discharged out of a system is maintainable to an average of 4% of stable value. Moreover, accommodation of the throughput by having made [more] the flow rate of transparency liquid than the flow rate of the transparency liquid in the above-mentioned basic mass balance can be easily performed by the intermittent running of a membrane separation device based on control of the sludge oil level in the above mentioned sludge supply tub 10. Consequently, the operation time of a membrane separation device serves as 22.5hr(s)/a day by control by the controller 50, and, in the circulation operation time of concentration sludge, 7.5hr(s)/a day, and discharge operation time serve as 15hr(s)/a day by control by the controller 46.

[0015] Drawing 3 is the mass-balance Fig. of the 2nd and 3rd model case. Drawing 3 (b) shows the mass balance when carrying out the same operation as the above, when the sludge concentration of original sludge falls to 0.8%. In this case, the operation time of a membrane separation device serves as 24hr(s)/full operation of a day, and, in the circulation operation time of concentration sludge, 12hr(s)/a day, and discharge operation time serve as 12hr(s)/a day.

[0016] Drawing 3 (b) shows the mass balance when carrying out the same operation as the above, when the sludge concentration of original sludge rises to 1.2%. In this case, the operation time of a membrane separation device serves as 21hr(s)/a day, and, in the circulation operation time of concentration sludge, 3hr(s)/a day, and discharge operation time serve as 18hr(s)/a day.

[0017] Even when the sludge concentration of original sludge is changed in the range which is 0.8 - 1.2%

according to the gestalt of this operation so that clearly from the above-mentioned 1st - the 3rd model case In a membrane separation device, always maintaining the sludge concentration of supply sludge to about 1.33% of stable value, a concentration rate can carry out 3 times as many quantum operation as this, and can always make sludge concentration of the concentration sludge discharged out of a system an average of 4% (4.1% of upper limits, 3.9% of minimums) of stable value. Fluctuation of sludge concentration is absorbable with change control of circulation operation / discharge operation of concentration sludge, and the intermittent running of a membrane separation device. For this reason, complicated control of original sludge, the control of flow of transparency liquid, etc. is not needed to fluctuation of sludge concentration, but concentration actuation of the sludge stabilized extremely can be carried out.

[0018] Drawing 4 displays the operation situation of the 1st model case according to each item by the timing diagram. (b) shows the flow rate of supply sludge and a flow rate shows the shutdown of a membrane separation device 20 on the way at the time zone of zero. In addition, a broken line shows the flow rate of original sludge. (b) shows the flow rate of transparency liquid. (Ha) shows the flow rate of concentration sludge, the Chuo Line bottom shows discharge operation and the bottom shows circulation operation. (d) shows the sludge concentration of concentration sludge, sludge concentration rises at the time of circulation operation of concentration sludge, and sludge concentration falls at the time of discharge operation. (e) shows the sludge oil level of the sludge supply tub 10, an oil level goes up at the time of circulation operation of concentration sludge, and an oil level descends at the time of discharge operation. Since the time amount of discharge operation is the circulation operation [twice], an oil level changes, descends at every operation, and serves as the lower limit L of liquid level control. Then, a membrane separation device 20 carries out shutdown. Since original sludge flows also during this shutdown at the sludge supply tub 10, an oil level goes abruptly up. If the upper limit H of liquid level control is reached, operation of a membrane separation device 20 will be resumed. Hereafter, the same operation pattern is repeated. since the sludge concentration and the flow rate of original sludge are alike every moment and are changed in actual operation, a timing diagram is considerably confused rather than what was shown in drawing 4 .

[0019] Drawing 5 is the mass-balance Fig. of the 4th and 5th model case, and shows the case where the 1st carried out the model case pair, and only the flow rate of supply sludge is changed. The 4th model case of drawing 5 (b) is the case where lessened the flow rate of supply sludge and it brings close to the flow rate of original sludge. Namely, the sludge concentration of supply sludge will serve as, and the sludge concentration of 1.0% of original sludge, and the flow rate of 100m, if operation of 4.0% of sludge concentration of 80m3/ hr, and concentration sludge is carried [the flow rate of supply sludge] out for the flow rate of 110m3/hr, and transparency liquid to 3/hr, as for the circulation operation time of 3.67 and concentration sludge, in 2.5hr(s)/a day, and discharge operation time, a concentration rate will serve as 20hr(s)/a day 1.09%. The fluctuation situation of the sludge oil level of the sludge supply tub 10 in this model case is illustrated to drawing 6 (b). In addition, drawing 6 (b) re-** the 1st model case of drawing 4 (e) for a comparison. On the other hand, the 5th model case of drawing 5 (b) is the case where the flow rate of supply sludge is made [many]. Namely, the sludge concentration of supply sludge will serve as, and the sludge concentration of 1.0% of original sludge, and the flow rate of 100m, if operation of 4.0% of sludge concentration of 80m3/hr, and concentration sludge is carried [the flow rate of supply sludge] out for the flow rate of 140m3/hr, and transparency liquid to 3/hr, as for the circulation operation time of 2.33 and concentration sludge, in 12.5hr(s)/a day, and discharge operation time, a concentration rate will serve as 10hr(s)/a day 1.71%. The fluctuation situation of the sludge oil level of the sludge supply tub 10 in this model case is illustrated to drawing 6 (Ha). The direction which, if possible, brought the flow rate of supply sludge close to the flow rate of original sludge can lessen the change frequency of circulation operation and discharge operation, and leads to stable operation so that clearly also from this comparison result. However, since the complicated control which includes the control of flow of transparency liquid by it becoming difficult to follow in footsteps of sludge concentration fluctuation [flow rate fluctuation of original sludge or], and to maintain proper operation ** Is needed when the flow rate of supply sludge is made to approach original sludge too much, it is not desirable. therefore -- as the approach of maintaining proper operation -- said controller 46 -- last circulation operation time (A) and discharge operation time (B) -- memorizing -- both ratio -- it is desirable to adjust the flow rate of supply sludge so that A/B may

go into the range of 1 / 10 - 1/2. namely, a ratio -- since the flow rate of supply sludge approaches original sludge too much when A/B becomes less than 1/10, a little setting flow rate of supply sludge is made to increase moreover, a ratio -- since there are too many flow rates of supply sludge when A/B exceeds one half, a little setting flow rate of supply sludge is decreased.

[0020] Drawing 7 is an equipment schematic diagram for explaining other operation gestalten of this invention. Since the element which attached the sign identically to drawing 1 in drawing 7 is the same element as what was shown in drawing 1 , it omits explanation. In drawing 7 , a by-pass line 52 branches in the duct 14 for circulation, and the other end of this by-pass line 52 joins the duct 40 for discharge. ** Flow-control-valve 52A is prepared in flow-control-valve 12A and a by-pass line 52 at the tee of the duct 14 for circulation. The opening of flow-control-valve 12A and flow-control-valve 52A is adjusted, respectively, and, for example, the concentration sludge of a moiety is made to discharge out of a system through a by-pass line 52 and the duct 40 for discharge in the above-mentioned configuration at the time of circulation operation.

[0021] Drawing 8 is the mass-balance Fig. of the 6th model case. That is, it is the case where operation which makes the flow rate of 120m3/hr and transparency liquid 4.0% of sludge concentration of 80m3/hr and concentration sludge for the flow rate of supply sludge, and discharges the concentration sludge of a moiety out of a system to 1.0% of sludge concentration of original sludge and flow rate of 100m 3/hr also at the time of circulation operation is carried out. In this case, as for 15hr(s)/a day, and discharge operation time, the circulation operation time of concentration sludge serves as [the sludge concentration of supply sludge] 7.5hr(s)/a day 1.33%. The fluctuation situation of the sludge oil level of the sludge supply tub 10 in this model case is illustrated to drawing 6 (d). thus -- if operation which discharges some concentration sludge out of a system at the time of circulation operation is carried out -- the change frequency of circulation operation and discharge operation -- ** -- it can lessen and leads to stable operation. Moreover, since the flow rate of the concentration sludge discharged out of a system equalizes, it may act advantageously to the latter sludge tank 38.

[0022] Said each operation gestalt explained the case where the change of circulation operation and discharge operation was automatically controlled with a controller 46 based on a sludge densitometer's 44 detection value prepared in the separation tub 22. However, this invention may be stationed not only in this, and a sludge densitometer may be stationed to ****** 32 or the ducts 36 other than separation tub 22.

[0023] Next, the cure at the time of abnormalities is explained. That is, the situation of the sludge concentration of concentration sludge not descending but continuing going up according to causes, like the sludge concentration of original sludge being unusually high depending on said discharge operation can be considered. the time of the sludge concentration of concentration sludge reaching the 2nd upper limit [still high concentration / upper limit / aforementioned] in preparation for such a situation in this invention -- extrusion operation -- ****** -- controlling like is desirable. Extrusion operation is operation which is made to discharge the concentration sludge of the amount equivalent to the supply sludge supplied from a membrane separation device 20, and sends it out out of a system, suspending membrane-separation processing in a membrane separation device 20. In this extrusion operation, membrane-separation processing is suspended by stopping operation of a suction pump 28. Supplying the supply sludge from sludge ****** 10 to a membrane separation device 20 is continued by this idle state. Then, the concentration sludge of the amount equivalent to the supplied supply sludge is extruded from the separation tub 22. If this extruded concentration sludge is sent out out of a system, a sequential permutation will be carried out at supply sludge, and sludge concentration will recover the concentration sludge in the separation tub 22 to normal values quickly.

[0024] Drawing 9 is a flow chart which shows the control procedure at the time of adding extrusion operation for a cure in such this invention at the time of such abnormalities. If it starts from circulation operation, circulation operation will be continued if the sludge concentration C of concentration sludge is under upper-limit **, and it becomes more than upper-limit **, it will change to discharge operation. If the sludge concentration C becomes under a lower limit by discharge operation, it will change to circulation operation, and discharge operation will be continued if it is under upper-limit **. When it should become more than upper-limit **, without the sludge concentration C descending also in discharge operation, it changes to extrusion operation. If the sludge concentration C becomes under upper-limit ** by extrusion operation, it will

change to discharge operation.
[0025]
[Effect of the Invention] According to the method of concentration of the sludge applied to this invention as above-mentioned, even when fluctuation of the sludge concentration of original sludge is large, without performing complicated feedback control, the load of a membrane separation device can be maintained to stability, and sludge concentration of the concentration sludge finally discharged out of a system can be made into fixed desired value. If the flow rate of supply sludge and transparency liquid is uniformly held in circulation operation and discharge operation and accommodation of throughput based on fluctuation of the sludge concentration of original sludge or inflow is especially performed by the intermittent running of a membrane separation device, stabilization of operation and simplification of control can be attained further. Moreover, if the setting flow rate of supply sludge is adjusted so that the ratio of the operation time of circulation operation and the operation time of discharge operation may be set to 1 / 10 - 1/2, the change frequency of circulation operation and discharge operation can be lessened, and stabilization of operation can be attained further. moreover -- if operation which discharges some concentration sludge out of a system at the time of circulation operation is carried out -- the change frequency of circulation operation and discharge operation -- ** -- it can lessen and leads to stable operation similarly.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The equipment schematic diagram for enforcing the concentration approach of the sludge concerning this invention.
[Drawing 2] The mass-balance Fig. of the 1st model case.
[Drawing 3] The mass-balance Fig. of the 2nd and 3rd model case.
[Drawing 4] The timing diagram which shows the operation situation of the 1st model case according to [various] an item.
[Drawing 5] The mass-balance Fig. of the 4th and 5th model case.
[Drawing 6] The timing diagram which compares aging of the sludge oil level in the sludge supply tub of the 1st, 4th, 5th, and 6th model case.
[Drawing 7] The equipment schematic diagram for explaining other operation gestalten of this invention.
[Drawing 8] The mass-balance Fig. of the 6th model case.
[Drawing 9] The flow chart which shows the control procedure at the time of adding extrusion operation for a cure at the time of abnormalities.
[Description of Notations]
10 .... Sludge supply tub
15 .... Selector valve
18 .... (supply sludge) Feed pump
20 .... Membrane separation device
22 .... Separation tub
24 .... Membrane module
28 .... (transparency liquid) Suction pump
32 .... ******
34 .... (concentration sludge) Eductor pump
38 .... Sludge tank
42 .... Selector valve
42 .... Sludge densitometer
46 .... Controller

[Translation done.]

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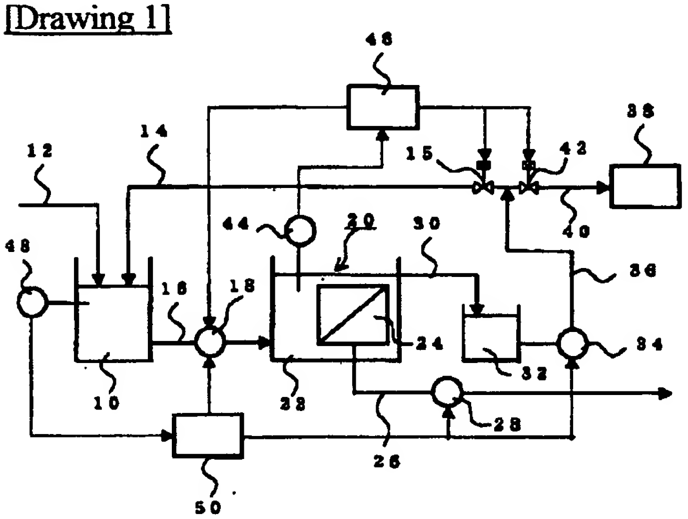
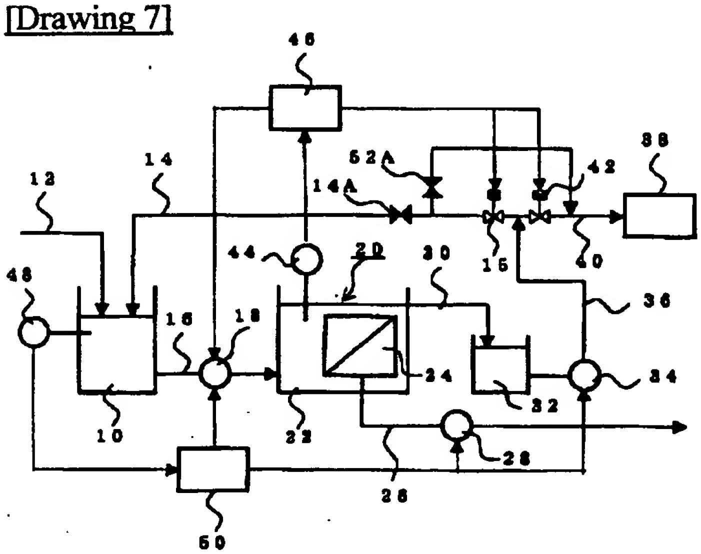
DRAWINGS

[Drawing 1]



[Drawing 7]



[Drawing 2]

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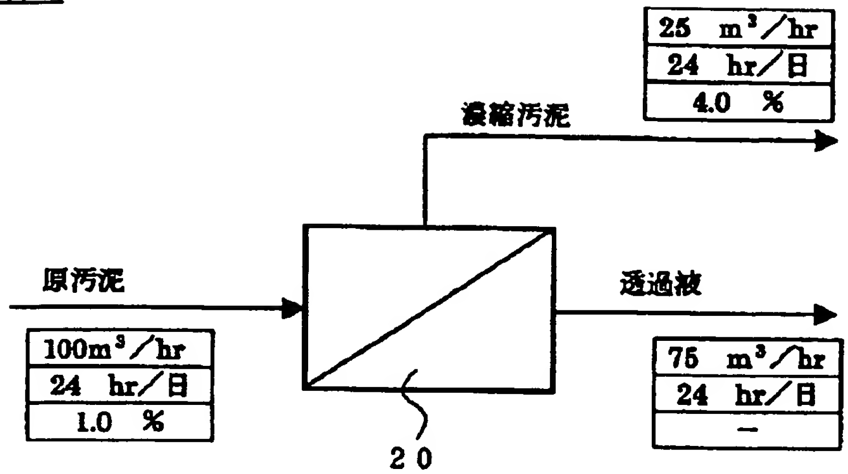
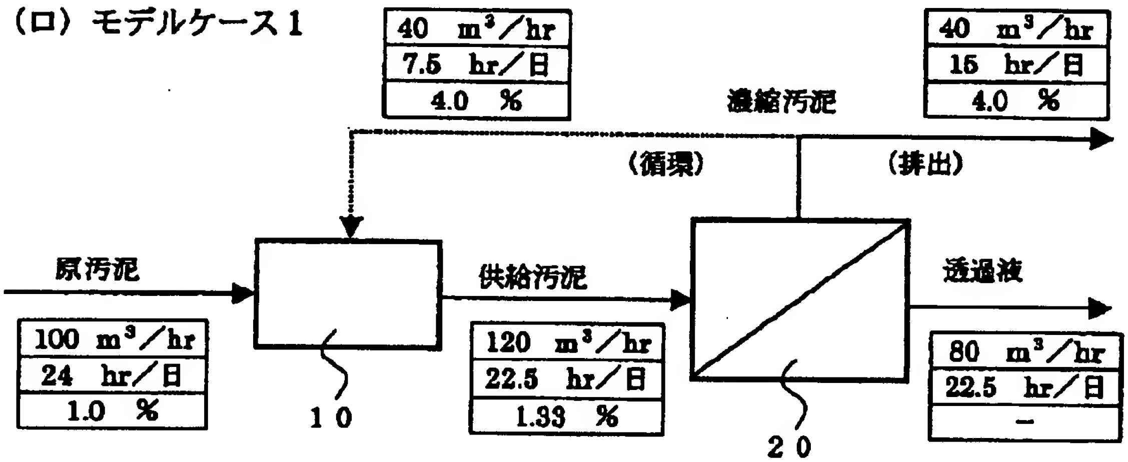
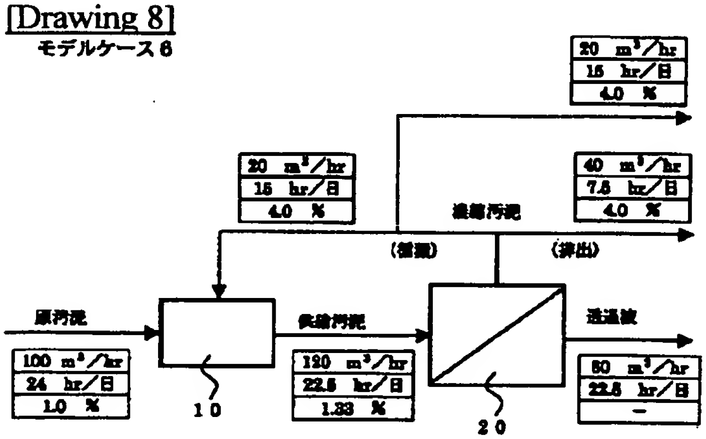


(ロ) モデルケース1



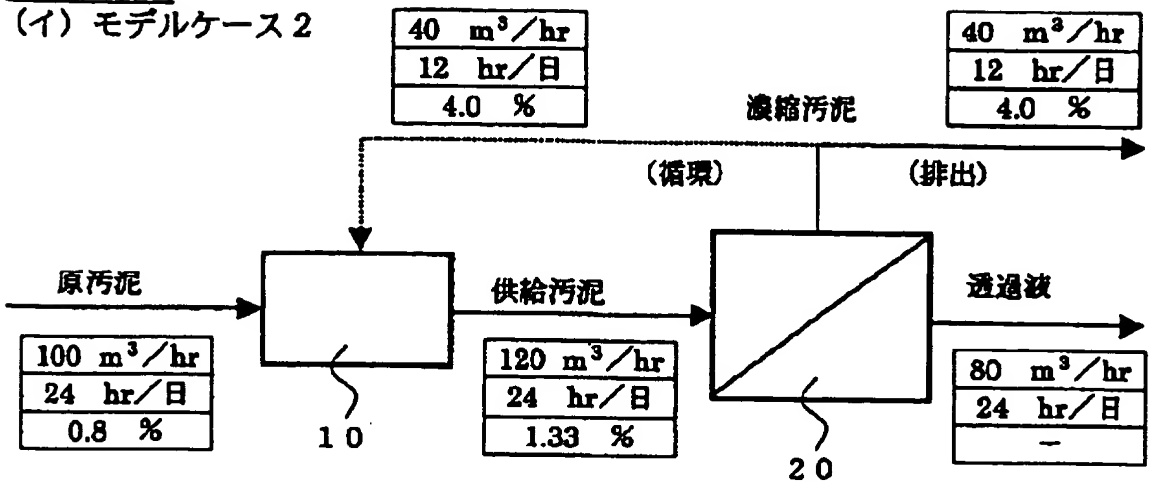
[Drawing 8]

モデルケース6



[Drawing 3]

(イ) モデルケース２



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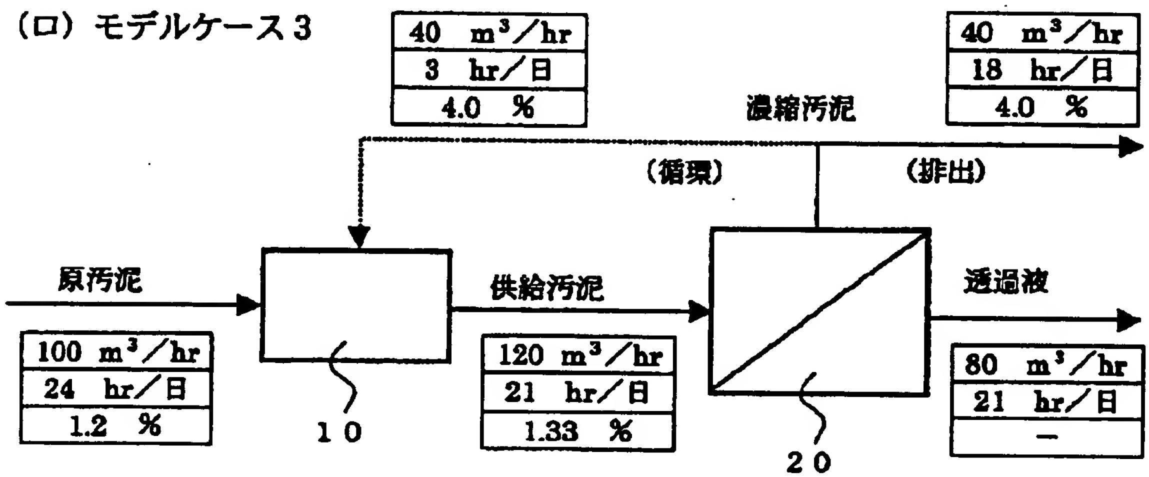

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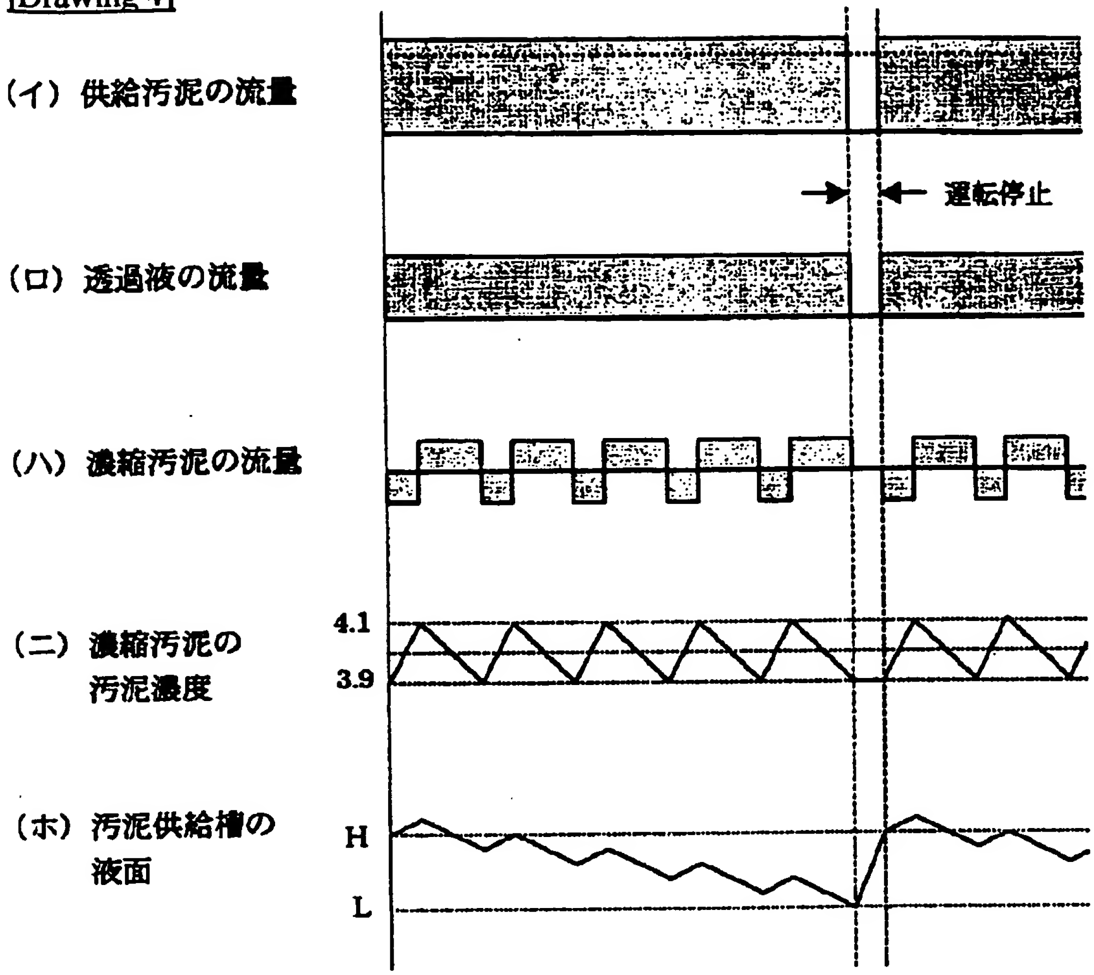

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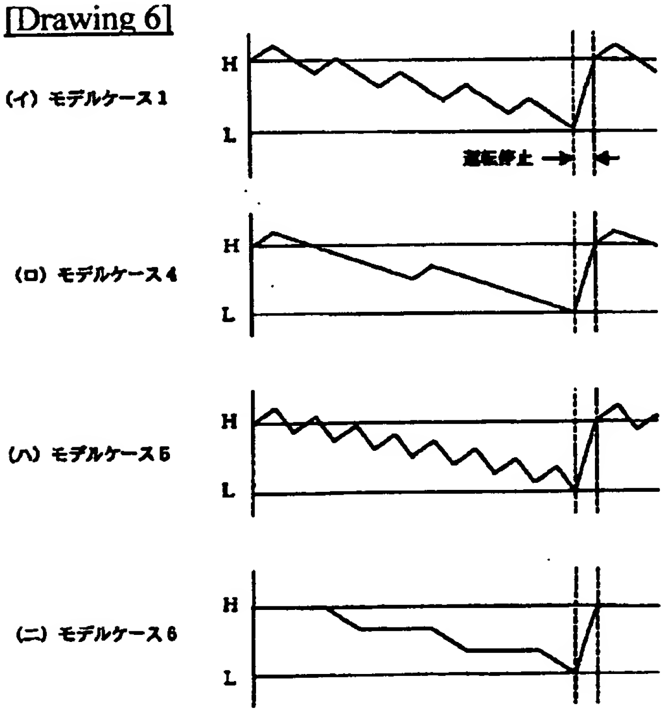
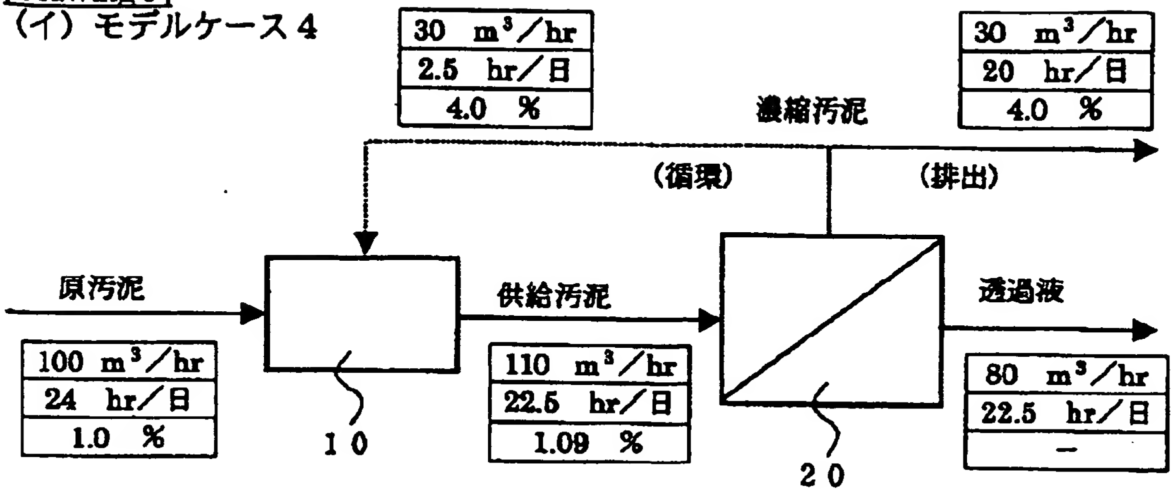
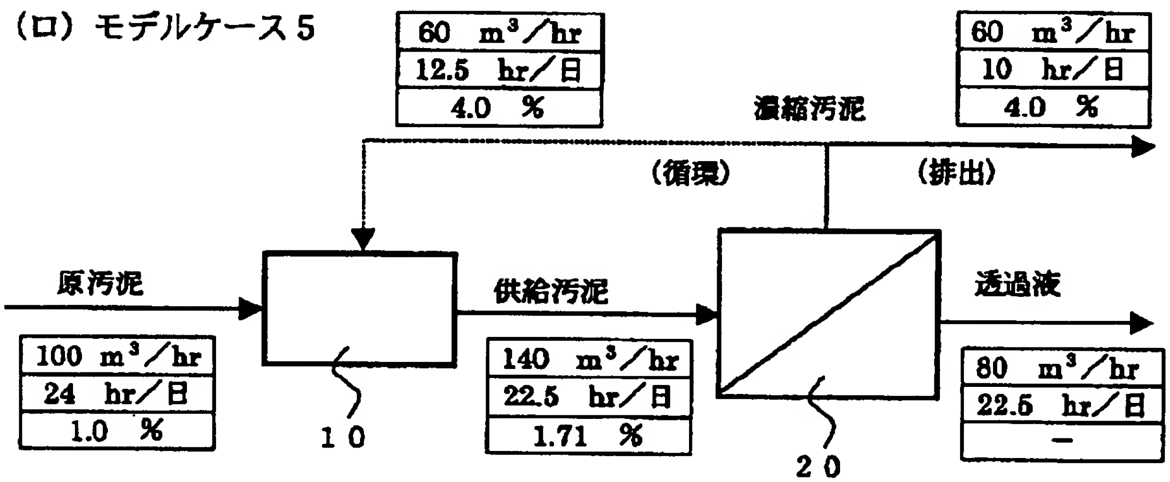


[Drawing 5]

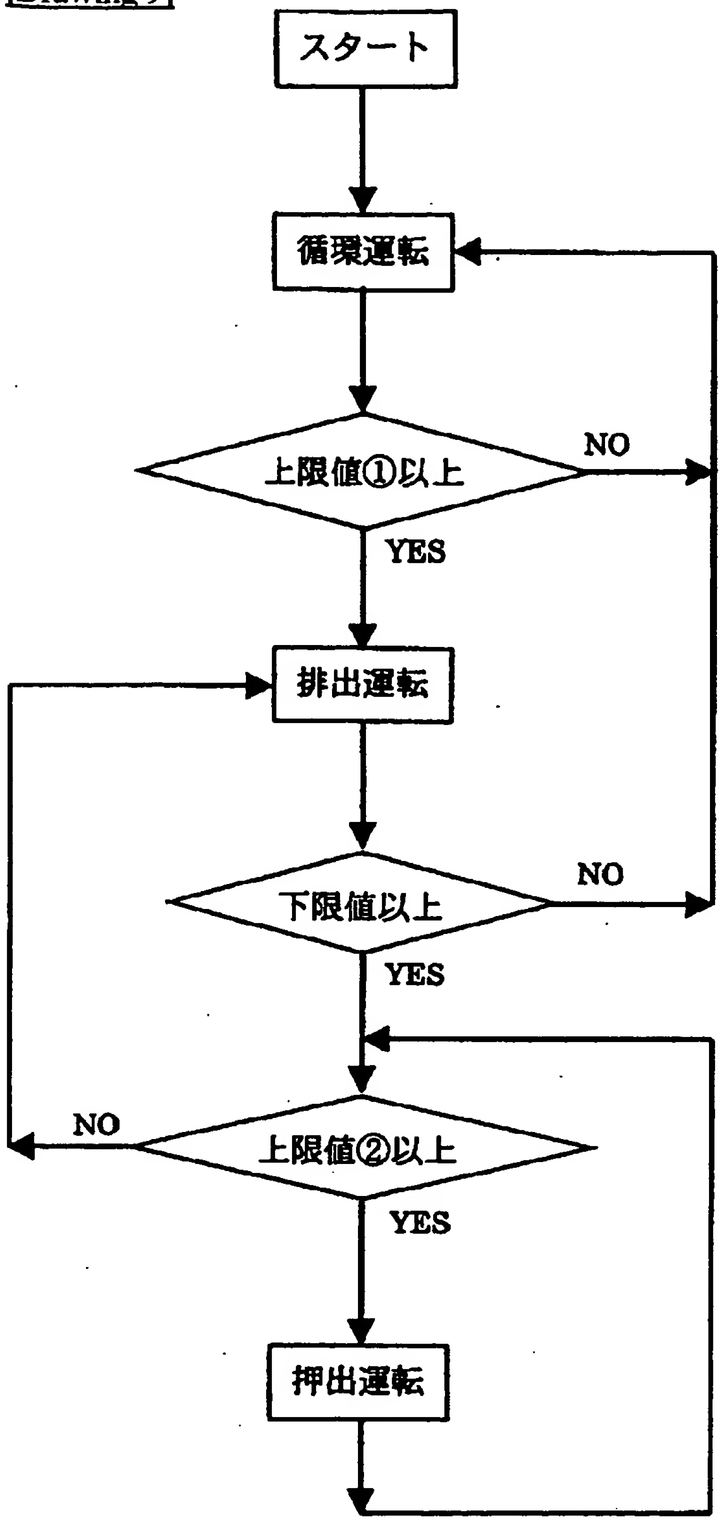
（イ）モデルケース４



（ロ）モデルケース５



[Drawing 9]



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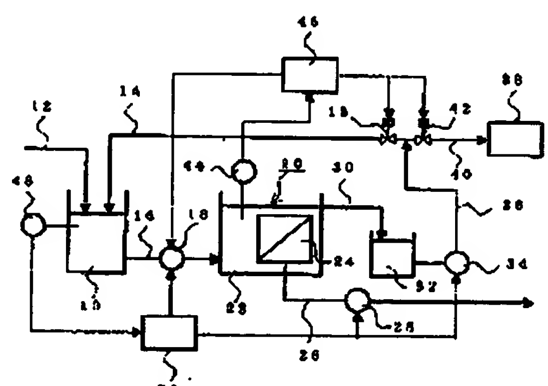
(54)【発明の名称】　汚泥の濃縮方法

(57)【要約】

【課題】　膜分離装置の負荷を安定に維持し、系外に排出する濃縮汚泥の汚泥濃度を一定の目標値にする。

【解決手段】　汚泥供給槽１０からの供給汚泥を膜分離装置２０に導き膜分離処理して透過液と濃縮汚泥とに分離する汚泥の濃縮方法であって、膜分離装置２０から排出される濃縮汚泥を汚泥供給槽１０に返送する循環運転と、濃縮汚泥の全量を系外に送り出す排出運転とを、汚泥濃度計４４の検出値に基づく切替弁１５，４２の切り替え制御によって交互に繰り返す。



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【特許請求の範囲】

【請求項１】汚泥供給槽からの供給汚泥を膜分離装置に導き膜分離処理して透過液と濃縮汚泥とに分離する汚泥の濃縮方法であって、

前記膜分離装置から排出される濃縮汚泥の少なくとも一部を前記汚泥供給槽に返送するとともに、残部を系外に送り出す循環運転を実施し、

この循環運転の結果、前記濃縮汚泥の汚泥濃度が上昇して上限値に達した時には膜分離装置から排出される濃縮汚泥の全量を系外に送り出す排出運転に切り替え、

この排出運転の結果、前記濃縮汚泥の汚泥濃度が下降して下限値に達した時には前記循環運転に切り替え、

循環運転と排出運転とを交互に繰り返すことを特徴とする汚泥の濃縮方法。

【請求項２】前記循環運転と排出運転においては供給汚泥と透過液の流量を一定に保持し、原汚泥の汚泥濃度の変動に基づく処理量の調節を前記膜分離装置の断続運転によって実行することを特徴とする請求項１に記載の汚泥の濃縮方法。

【請求項３】前記循環運転と排出運転の運転時間比が１／１０～１／２となるように供給汚泥の設定流量を調節することを特徴とする請求項１又は請求項２に記載の汚泥の濃縮方法。

【請求項４】汚泥供給槽からの供給汚泥を膜分離装置に導き膜分離処理して透過液と濃縮汚泥とに分離する汚泥の濃縮方法であって、前記膜分離装置から排出される濃縮汚泥の少なくとも一部を前記汚泥供給槽に返送するとともに、残部を系外に送り出す循環運転を実施し、この循環運転の結果、前記濃縮汚泥の汚泥濃度が上昇して第１の上限値に達した時には膜分離装置から排出される濃縮汚泥の全量を系外に送り出す排出運転に切り替え、この排出運転の結果、前記濃縮汚泥の汚泥濃度が下降して下限値に達した時には前記循環運転に切り替え、循環運転と排出運転とを交互に繰り返すとともに、前記排出運転によっても前記濃縮汚泥の汚泥濃度が下降せず、濃縮汚泥の汚泥濃度が前記第１の上限値よりもさらに高濃度な第２の上限値に達した時には膜分離装置では膜分離処理を停止しつつ、供給される供給汚泥に相当する量の濃縮汚泥を膜分離装置から排出させ系外に送り出す排出運転を実施することを特徴とする汚泥の濃縮方法。

【請求項５】前記膜分離装置は分離槽と、この分離槽内の濃縮汚泥に浸漬された膜モジュールと、濃縮汚泥の液面を一定に保持する濃縮汚泥の排出手段とを具備していることを特徴とする請求項１乃至請求項４のいずれかに記載の汚泥の濃縮方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は汚泥の濃縮方法に係り、特に汚泥を膜分離処理して透過液と濃縮汚泥とに分離する汚泥の濃縮方法に関する。

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【０００２】

【従来の技術】廃水処理や浄水処理の分野では、生物学的や物理化学的な処理によって発生した汚泥を膜分離処理して透過液と濃縮汚泥とに分離することが行われている。濃縮のための膜分離装置としては、濃縮汚泥を満たした分離槽内に膜モジュールを浸漬したのものが知られている。この浸漬式の膜分離装置においては、定量の原汚泥を分離槽に連続的に供給しつつ、膜モジュールから吸引する透過液の流量を一定に保持する運転が一般的に行われている。分離槽からオーバーフローして排出される濃縮汚泥の量も原汚泥と透過液の差分として一定となる運転であった。濃縮汚泥の汚泥濃度は原汚泥量と濃縮汚泥量との比である濃縮倍率によって定まる。したがって、上記のような濃縮倍率が一定の運転では原汚泥の汚泥濃度が変動した場合には濃縮汚泥の汚泥濃度も比例して変動する。

【０００３】

【発明が解決しようとする課題】上述の濃縮方法によれば量的な観点からは安定な処理が可能であるが、何らかの原因によって原汚泥の汚泥濃度が高くなった時には、濃縮汚泥の汚泥濃度も高くなり、透過膜の目詰まりなどを誘発して膜分離装置の運転操作上の不具合を招く。また、濃縮汚泥は後段処理として脱水、天日乾燥、焼却などの処理を受けるが、濃縮汚泥の汚泥濃度が変動すると後段処理の負荷や運転が不安定となり、処理性能や効率を低下させるという問題点があった。

【０００４】このような問題点を解決するために、濃縮汚泥の汚泥濃度を計測し、その計測結果に基づいて濃縮汚泥の汚泥濃度が目標値となるように原汚泥や透過液の流量をフィードバック制御することが考えられる。しかしながら、このような方法はフィードバック制御を実現するための装置構成が複雑で高価になるとともに、原汚泥の汚泥濃度の変動が大きい場合には膜分離装置の負荷も追随して変動することになり、運転の不安定を招く。本発明の目的は、上記従来技術の問題点を改善し、原汚泥の汚泥濃度の変動が大きい場合でも、複雑なフィードバック制御を行うことなく膜分離装置の負荷を安定に維持し、かつ、最終的に系外に排出する濃縮汚泥の汚泥濃度を一定の目標値にすることができる汚泥の濃縮方法を提供することにある。

【０００５】

【課題を解決するための手段】上記の課題を解決するために、本発明に係る汚泥の濃縮方法は、汚泥供給槽からの供給汚泥を膜分離装置に導き膜分離処理して透過液と濃縮汚泥とに分離する汚泥の濃縮方法であって、前記膜分離装置から排出される濃縮汚泥の少なくとも一部を前記汚泥供給槽に返送するとともに、残部を系外に送り出す循環運転を実施し、この循環運転の結果、前記濃縮汚泥の汚泥濃度が上昇して上限値に達した時には膜分離装置から排出される濃縮汚泥の全量を系外に送り出す排出

運転に切り替え、この排出運転の結果、前記濃縮汚泥の汚泥濃度が下降して下限値に達した時には前記循環運転に切り替え、循環運転と排出運転とを交互に繰り返すことを特徴とする。なお、本発明において「上限値（下限値）に達した時」の「達した時」という用語は、「その値に接近した時」「丁度、その値となった時」「その値を超えた時」のいずれにも理解し得るものとする。

【０００６】また、本発明に係る汚泥の濃縮方法は上記の構成において、前記循環運転と排出運転においては供給汚泥と透過液の流量を一定に保持し、原汚泥の処理量の調節を前記膜分離装置の断続運転によって実行することを特徴とする。また、本発明に係る汚泥の濃縮方法は上記の構成において、前記循環運転と排出運転の運転時間比が１／１０～１／２となるように供給汚泥の設定流量を調節することを特徴とする。

【０００７】また、本発明に係る汚泥の濃縮方法は上記の構成において、前記膜分離装置は分離槽と、この分離槽内の濃縮汚泥に浸漬された膜モジュールと、濃縮汚泥の液面を一定に保持する濃縮汚泥の排出手段とを具備していることを特徴とする。

【０００８】

【発明の実施の形態】図１は本発明に係る汚泥の濃縮方法を実施するための装置系統図である。図１において汚泥供給槽１０には管路１２から濃縮対象物である原汚泥が流入する。また、この汚泥供給槽１０には管路１４から後述するように濃縮汚泥が間欠的に返送される。汚泥供給槽１０は管路１６によって膜分離装置２０と接続され、汚泥供給槽１０内の汚泥は管路１６の途中に設けた供給ポンプ１８によって、膜分離装置２０に供給される。本発明においては、このような汚泥供給槽１０から膜分離装置２０に供給される汚泥を供給汚泥と定義し、前記原汚泥と区別する。膜分離装置２０は主として分離槽２２と、この分離槽２２内の濃縮汚泥に浸漬された膜モジュール２４とからなる。膜モジュール２４の二次側には管路２６が接続され、この管路２６に設けた吸引ポンプ２８によって、膜モジュール２４の濾過膜を濾過した透過液が管路２６から抜き出され、系外に排出される。また、膜分離によって濃縮された分離槽２２内の濃縮汚泥は、その液面が一定に保持されつつ、オーバーフロー分が管路３０から排出される。

【０００９】膜モジュール２４の膜材としては有機材料又はセラミック材料で形成された精密濾過膜又は限外濾過膜が用いられる。膜モジュール２４の型式としては浸漬式の中空糸膜、平膜が好ましく、特に円盤状の平膜を回転させるようにした回転平膜式の膜モジュールが汚泥の濃縮用に好都合である。しかしながら、本発明に係る膜分離装置は上記の浸漬式の膜モジュールを用いたものに限らず、例えば管型の膜モジュールを用いたものにも適用可能である。

【００１０】管路３０から排出された濃縮汚泥は汚泥溜

３２を経由したのち、排出ポンプ３４によって管路３６から前記汚泥供給槽１０又は汚泥貯槽３８のいずれか一方に送出される。すなわち、管路３６は循環用の管路１４と排出用の管路４０とに分岐しており、管路１４には切替弁１５が、管路４０には切替弁４２が設けられている。この切替弁１５と切替弁４２とを操作することによって、管路３６からの濃縮汚泥は管路１４を介して汚泥供給槽１０に返送されるか、又は管路４２を介して汚泥貯槽３８に排出される。切替弁１５と切替弁４２の操作は前記分離槽２２に配設した汚泥濃度計４４の検出信号を取り込む制御器４６によって制御される。なお、この制御器４６は膜分離装置２０の運転状況に応じて、供給汚泥の設定流量を調節する信号を供給ポンプ１８に出力する機能を備えている。また、汚泥供給槽１０には液面計４８が配設され、この液面計４８の検出信号を取り込んだ制御器５０によって、供給ポンプ１８、吸引ポンプ２８及び排出ポンプ３４の稼動、停止が制御される。なお、分離槽２２内の濃縮汚泥の液面を一定に保持する濃縮汚泥の排出手段としては前記したオーバーフローによる方法に限らない。分離槽２２内に設けた液面計の指示値が一定となるように排出ポンプ３４による濃縮汚泥の引き抜き量を制御するようにしてもよい。

【００１１】上記の構成において、汚泥供給槽１０には管路１２から原汚泥が連続的又は間欠的に流入する。また、汚泥供給槽１０には管路１４から濃縮汚泥が間欠的に流入する。これらの原汚泥と濃縮汚泥が汚泥供給槽１０内で混合し、原汚泥よりは汚泥濃度が比較的高い濃度に調整された供給汚泥が膜分離装置２０に供給される。膜分離装置２０では供給される供給汚泥の流量及び膜モジュール２４から吸引する透過液の流量を一定に保持する運転をする。その結果、分離槽２２をオーバーフローして排出される濃縮汚泥の流量も一定に保持される。なお、分離槽２２内の濃縮汚泥の汚泥濃度は汚泥濃度計４４によって連続的に又は適当な制御間隔で検出され、制御器４６にその検出信号が送信される。

【００１２】上記の運転において、切替弁１５を開、切替弁４２を閉とし、分離槽２２から排出される濃縮汚泥の全量を汚泥供給槽１０に返送する循環運転をしたとする。この循環運転の結果、供給汚泥の濃度が徐々に上昇し、それにつれて分離槽２２内の濃縮汚泥の汚泥濃度も徐々に上昇する。汚泥濃度計４４によって検出される濃縮汚泥の汚泥濃度が上限値に達すると、その信号を受けた制御器４６は切替信号を発信して切替弁１５を閉、切替弁４２を開とする。その結果、分離槽２２から排出される濃縮汚泥の全量を汚泥貯槽４０に送り出し系外に排出する排出運転に切り替わる。この排出運転の結果、汚泥供給槽１０内の汚泥濃度が比較的高い汚泥が管路１２から流入する原汚泥によって希釈され、供給汚泥の濃度が徐々に下降し、それにつれて分離槽２２内の濃縮汚泥の汚泥濃度も徐々に下降する。汚泥濃度計４４によって

検出される濃縮汚泥の汚泥濃度が下限値に達すると制御器４６は切替信号を発信して循環運転に切り替える。以降、上記の循環運転と排出運転を交互に繰り返す運転を継続する。この際、制御器４６における上限値と下限値の設定を目標とする濃縮汚泥の汚泥濃度に近接させることにより、系外に排出する濃縮汚泥の汚泥濃度を上限値と下限値の範囲内の安定した値に維持することができる。しかも、この間の供給汚泥、透過液及び濃縮汚泥の流量がいずれも一定に保持されるので運転の単純化と安定を図ることができる。なお、上記の運転では流入する原汚泥の流量Ｑ１と、系外に排出される透過液と濃縮汚泥の合計流量Ｑ２は各時間帯でアンバランスとなる。したがって、本発明においては流量Ｑ２を大き目に設定しておき、この時のアンバランス量＝（（流量Ｑ２－流量Ｑ１）×時間）を膜分離装置の断続運転によって吸収することが好ましい。すなわち、図１において、管路１２から流入する原汚泥の流量Ｑ１に対して、供給汚泥の流量を十分に大きく設定し、系外に排出される透過液と濃縮汚泥の合計流量Ｑ２が、流量Ｑ２＞流量Ｑ１となるように運転する。その結果、汚泥供給槽１０の汚泥液面が徐々に低下する。汚泥液面の下限値を液面計４８で検出し、その信号に基づいて制御器５０では供給ポンプ１８、吸引ポンプ２８及び排出ポンプ３４の稼動を停止させる。この膜分離装置の運転停止中に原汚泥が汚泥供給槽１０に流入することによって汚泥液面が回復し、汚泥液面の上限値を液面計４８が検出すると制御器５０は供給ポンプ１８、吸引ポンプ２８及び排出ポンプ３４の起動させ、膜分離処理を再開する。

【００１３】次に、いろいろなモデルケースのマスバランスについて説明する。図２は第１のモデルケースのマスバランス図である。図２（イ）は汚泥濃度が１.０％の原汚泥が流量１００m³／ｈｒで一日当たり２４時間連続的に流入し、この原汚泥を連続的に膜分離処理して汚泥濃度が４.０％の濃縮汚泥を得る場合の基本マスバランスを示している。この場合、原汚泥が４倍に濃縮される結果、濃縮汚泥と透過液の流量はそれぞれ２５m³／ｈｒ、７５m³／ｈｒとなる。図２（ロ）は原汚泥が（イ）と同一の時に本発明に係る方法を実施した場合のマスバランスを例示したものである。本例においては汚泥供給槽１０からの供給汚泥の流量を原汚泥が流量よりも十分に多い１２０m³／ｈｒとし、透過液の流量も上記基本マスバランスでの透過液の流量よりも多い８０m³／ｈｒに設定して運転する。その結果、膜分離装置から排出される濃縮汚泥の流量は４０m³／ｈｒとなり、濃縮倍率が３倍の運転となる。この濃縮倍率によって汚泥濃度が４.０％の濃縮汚泥を得るためには供給汚泥の汚泥濃度を原汚泥よりも十分に高い４／３＝１.３３％に調整する必要がある。そのために、濃縮汚泥の循環運転と排出運転の切り替えが行われる。

【００１４】実際の制御では濃縮汚泥の汚泥濃度の上限

値を４.１％、下限値を３.９％とし、濃縮汚泥の汚泥濃度が４.１％に達すると循環運転から排出運転に切り替える。また、排出運転の結果、濃縮汚泥の汚泥濃度が３.９％に達すると循環運転に切り替える。この循環運転と排出運転の切り替え制御を繰り返すことによって、供給汚泥の汚泥濃度は必然的に１.３３％に収束するとともに、系外に排出する濃縮汚泥の汚泥濃度を平均４％の安定した値に維持することができる。また、透過液の流量を上記基本マスバランスでの透過液の流量よりも多くしたことによる処理量の調節は、前記した汚泥供給槽１０での汚泥液面の制御に基づく膜分離装置の断続運転によって容易に実行することができる。その結果、膜分離装置の稼動時間は制御器５０による制御によって２２.５ｈｒ／日となり、制御器４６による制御によって濃縮汚泥の循環運転時間は７.５ｈｒ／日、排出運転時間は１５ｈｒ／日となる。

【００１５】図３は第２、第３のモデルケースのマスバランス図である。図３（イ）は原汚泥の汚泥濃度が０.８％に低下した場合に上記と同様の運転をした時のマスバランスを示したものである。この場合には、膜分離装置の稼動時間が２４ｈｒ／日のフル稼動となり、濃縮汚泥の循環運転時間は１２ｈｒ／日、排出運転時間は１２ｈｒ／日となる。

【００１６】図３（ロ）は原汚泥の汚泥濃度が１.２％に上昇した場合に上記と同様の運転をした時のマスバランスを示したものである。この場合には、膜分離装置の稼動時間が２１ｈｒ／日となり、濃縮汚泥の循環運転時間は３ｈｒ／日、排出運転時間は１８ｈｒ／日となる。

【００１７】上述の第１～第３のモデルケースから明らかなように、本実施の形態によれば原汚泥の汚泥濃度が０.８～１.２％の範囲で変動した場合でも、膜分離装置では供給汚泥の汚泥濃度を常に約１．３３％の安定した値に維持しつつ、濃縮倍率が３倍の定量運転を実施でき、系外に排出する濃縮汚泥の汚泥濃度を常に平均４％（上限４.１％、下限３.９％）の安定した値にすることができる。汚泥濃度の変動は濃縮汚泥の循環運転／排出運転の切り替え制御と膜分離装置の断続運転とによって吸収することができる。このため、汚泥濃度の変動に対して原汚泥や透過液の流量制御などの複雑な制御を必要とせず、きわめて安定した汚泥の濃縮操作を実施できる。

【００１８】図４は第１のモデルケースの運転状況を各項目別にタイムチャートで表示したものである。（イ）は供給汚泥の流量を示し、途中で流量がゼロの時間帯は膜分離装置２０の運転停止を示す。なお、破線は原汚泥の流量を示す。（ロ）は透過液の流量を示す。（ハ）は濃縮汚泥の流量を示し、中央線の上側は排出運転、下側は循環運転を示す。（ニ）は濃縮汚泥の汚泥濃度を示し、濃縮汚泥の循環運転時には汚泥濃度が上昇し、排出運転時には汚泥濃度が低下する。（ホ）は汚泥供給槽１

０の汚泥液面を示し、濃縮汚泥の循環運転時には液面が上昇し、排出運転時には液面が下降する。排出運転の時間が循環運転の２倍であるため、液面は切り替え運転の度に下降し、液面制御の下限値Ｌとなる。すると膜分離装置２０が運転停止する。この運転停止中にも原汚泥が汚泥供給槽１０に流入するので液面は急上昇する。液面制御の上限値Ｈに達すると膜分離装置２０の運転が再開される。以下、同様の運転パターンを繰り返す。実際の運転では原汚泥の汚泥濃度や流量が時々刻々に変動するので、タイムチャートは図４に示したものよりもかなり乱れる。

【００１９】図５は第４、第５のモデルケースのマスバランス図であり、第１のモデルケース対して供給汚泥の流量のみを変化させた場合を示したものである。図５（イ）の第４のモデルケースは供給汚泥の流量を少なくして原汚泥の流量に近づけた場合である。すなわち、原汚泥の汚泥濃度１．０％、流量１００ｍ³／ｈｒに対して、供給汚泥の流量を１１０ｍ³／ｈｒ、透過液の流量を８０ｍ³／ｈｒ、濃縮汚泥の汚泥濃度４．０％の運転を実施すると、供給汚泥の汚泥濃度が１．０９％、濃縮倍率が３．６７、濃縮汚泥の循環運転時間は２．５ｈｒ／日、排出運転時間は２０ｈｒ／日となる。このモデルケースにおける汚泥供給槽１０の汚泥液面の変動状況を図６（ロ）に例示する。なお、図６（イ）は比較のために図４（ホ）の第１のモデルケースを再掲したものである。一方、図５（ロ）の第５のモデルケースは供給汚泥の流量を多くした場合である。すなわち、原汚泥の汚泥濃度１．０％、流量１００ｍ³／ｈｒに対して、供給汚泥の流量を１４０ｍ³／ｈｒ、透過液の流量を８０ｍ³／ｈｒ、濃縮汚泥の汚泥濃度４．０％の運転を実施すると、供給汚泥の汚泥濃度が１．７１％、濃縮倍率が２．３３、濃縮汚泥の循環運転時間は１２．５ｈｒ／日、排出運転時間は１０ｈｒ／日となる。このモデルケースにおける汚泥供給槽１０の汚泥液面の変動状況を図６（ハ）に例示する。この比較結果からも明らかなように、供給汚泥の流量をなるべく原汚泥の流量に近づけた方が、循環運転と排出運転との切り替え頻度を少なくすることができ、安定運転につながる。ただし、供給汚泥の流量を原汚泥に接近させ過ぎると、原汚泥の流量変動や汚泥濃度変動に追随して適正運転を維持することが難しくなり、透過液の流量制御を含む複雑な制御が必要になるので好ましくない。したがって、適正運転を維持する方法として、前記制御器４６では直前の循環運転時間（Ａ）と排出運転時間（Ｂ）とを記憶しておき、両者の比Ａ／Ｂが１／１０～１／２の範囲に入るように供給汚泥の流量を調節することが好ましい。すなわち、比Ａ／Ｂが１／１０未満となった時は供給汚泥の流量が原汚泥に接近し過ぎているので、供給汚泥の設定流量を少し増加させる。また、比Ａ／Ｂが１／２を超えた時は供給汚泥の流量が多すぎるので、供給汚泥の設定流量を少し減少させる。

【００２０】図７は本発明の他の実施形態を説明するための装置系統図である。図７において図１と同一に符号を付した要素は、図１に示したものと同様の要素であるので説明を省略する。図７において循環用の管路１４にはバイパス管路５２が分岐し、このバイパス管路５２の他端は排出用の管路４０に合流している。循環用の管路１４の分岐部には流量調節弁１２Ａ、バイパス管路５２には流量調節弁５２Ａが設けられている。上記の構成において、流量調節弁１２Ａと流量調節弁５２Ａの開度をそれぞれ調節し、循環運転時においても、例えば半量の濃縮汚泥をバイパス管路５２と排出用の管路４０を介して系外に排出させる。

【００２１】図８は第６のモデルケースのマスバランス図である。すなわち、原汚泥の汚泥濃度１．０％、流量１００ｍ³／ｈｒに対して、供給汚泥の流量を１２０ｍ³／ｈｒ、透過液の流量を８０ｍ³／ｈｒ、濃縮汚泥の汚泥濃度４．０％とし、循環運転時にも半量の濃縮汚泥を系外に排出する運転を実施するケースである。このケースでは供給汚泥の汚泥濃度が１．３３％、濃縮汚泥の循環運転時間は１５ｈｒ／日、排出運転時間は７．５ｈｒ／日となる。このモデルケースにおける汚泥供給槽１０の汚泥液面の変動状況を図６（ニ）に例示する。このように、循環運転時に濃縮汚泥の一部を系外に排出する運転を実施すると、循環運転と排出運転との切り替え頻度をすこし少なくすることができ、安定運転につながる。また、系外に排出される濃縮汚泥の流量が平均化するので、後段の汚泥貯槽３８に対して有利に作用する場合がある。

【００２２】前記各実施形態では、分離槽２２に設けた汚泥濃度計４４の検出値に基づき制御器４６によって循環運転と排出運転の切り替えを自動制御する場合について説明した。しかしながら、本発明はこれに限らず、汚泥濃度計は分離槽２２以外の例えば汚泥溜３２又は管路３６に配置してもよい。

【００２３】次に、異常時の対策について説明する。すなわち、原汚泥の汚泥濃度が異常に高いなどの原因によって、前記排出運転によっては濃縮汚泥の汚泥濃度が下降せず上昇し続けるという事態が考えられる。本発明ではこのような事態に備えて、濃縮汚泥の汚泥濃度が前記の上限値よりもさらに高濃度な第２の上限値に達した時には押出運転を実施するように制御することが好ましい。押出運転とは膜分離装置２０では膜分離処理を停止しつつ、供給される供給汚泥に相当する量の濃縮汚泥を膜分離装置２０から排出させ系外に送り出す運転である。この押出運転では吸引ポンプ２８の稼動を停止することによって、膜分離処理を停止する。この停止状態で汚泥供給槽１０からの供給汚泥を膜分離装置２０に供給し続ける。すると供給された供給汚泥に相当する量の濃縮汚泥が分離槽２２から押出される。この押出された濃縮汚泥

を系外に送り出せば、分離槽２２内の濃縮汚泥は供給汚泥に順次置換されて、汚泥濃度が急速に正常値に回復する。

【００２４】図9はこのような本発明においてこのような異常時対策用の押出運転を付加した場合の制御手順を示すフローチャートである。循環運転からスタートし、濃縮汚泥の汚泥濃度Ｃが上限値①未満であれば循環運転を継続し、上限値①以上になると排出運転に切り替える。排出運転によって汚泥濃度Ｃが下限値未満になると循環運転に切り替え、上限値②未満であれば排出運転を継続する。万一、排出運転よっても汚泥濃度Ｃが下降せずに上限値②以上となった時には押出運転に切り替える。押出運転によって汚泥濃度Ｃが上限値②未満になると排出運転に切り替える。

【００２５】

【発明の効果】上述のとおり、本発明に係る汚泥の濃縮方法によれば、原汚泥の汚泥濃度の変動が大きい場合でも、複雑なフィードバック制御を行うことなく膜分離装置の負荷を安定に維持し、かつ、最終的に系外に排出する濃縮汚泥の汚泥濃度を一定の目標値にすることができる。特に循環運転と排出運転においては供給汚泥と透過液の流量を一定に保持し、原汚泥の汚泥濃度や流入量の変動に基づく処理量の調節を膜分離装置の断続運転によって実行すると、より一層、運転の安定化と制御の簡素化を図ることができる。また、循環運転の運転時間と排出運転の運転時間との比が１／１０～１／２となるように供給汚泥の設定流量を調節すると、循環運転と排出運転の切り替え頻度を少なくすることができ、より一層、運転の安定化を図ることができる。また、循環運転時に濃縮汚泥の一部を系外に排出する運転を実施すると、循環運転と排出運転との切り替え頻度をす少なくすることができ、同様に安定運転につながる。

【図面の簡単な説明】

【図１】本発明に係る汚泥の濃縮方法を実施するための装置系統図。

【図２】第１のモデルケースのマスバランス図。

【図３】第２、第３のモデルケースのマスバランス図。

【図４】第１のモデルケースの運転状況を各種項目別に示すタイムチャート。

【図５】第４、第５のモデルケースのマスバランス図。

【図６】第１、第４、第５、第６のモデルケースの汚泥供給槽における汚泥液面の経時変化を比較するタイムチャート。

【図７】本発明の他の実施形態を説明するための装置系統図。

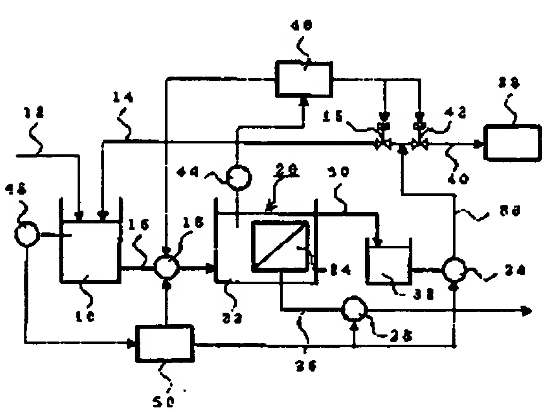
【図８】第６のモデルケースのマスバランス図。

【図９】異常時対策用の押出運転を付加した場合の制御手順を示すフローチャート。

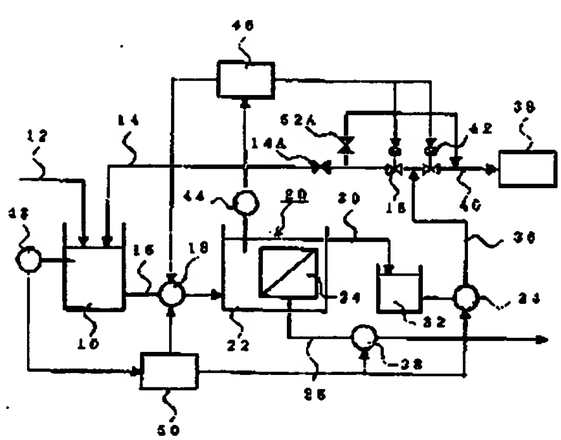
【符号の説明】

１０……汚泥供給槽
１５……切替弁
１８……（供給汚泥の）供給ポンプ
２０……膜分離装置
２２……分離槽
２４……膜モジュール
２８……（透過液の）吸引ポンプ
３２……汚泥溜
３４……（濃縮汚泥の）排出ポンプ
３８……汚泥貯槽
４２……切替弁
４２……汚泥濃度計
４６……制御器

【図１】

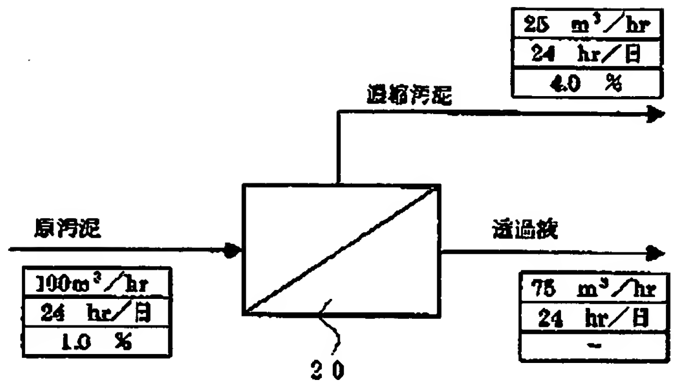


【図７】

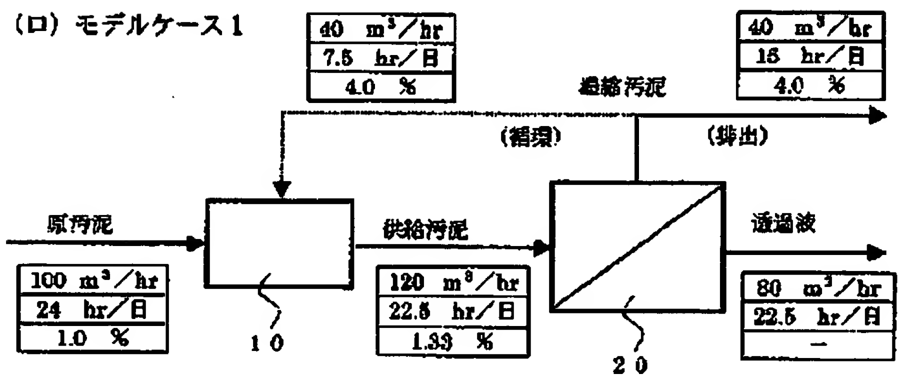


【図２】

（イ）

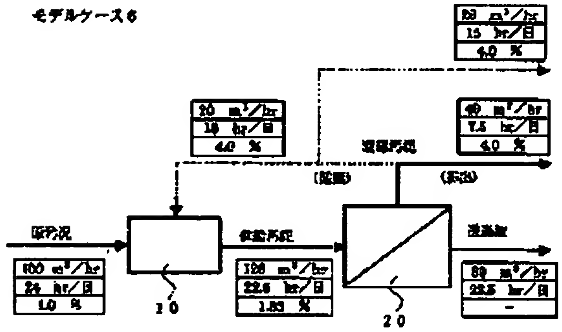


（ロ）モデルケース１



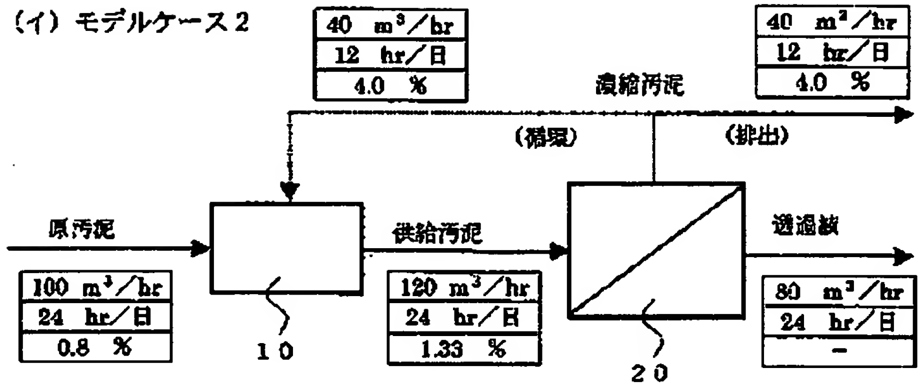
【図８】

モデルケース６

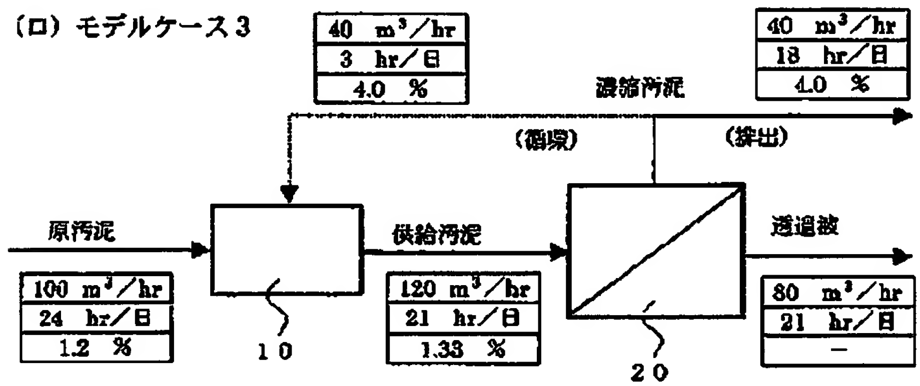


【図3】

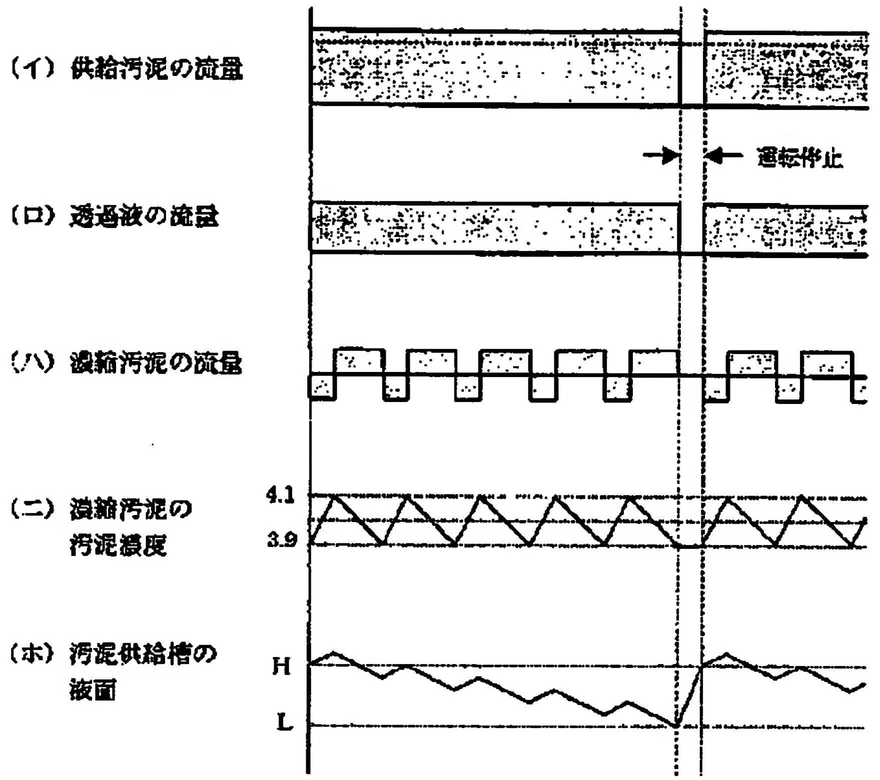
(イ) モデルケース2



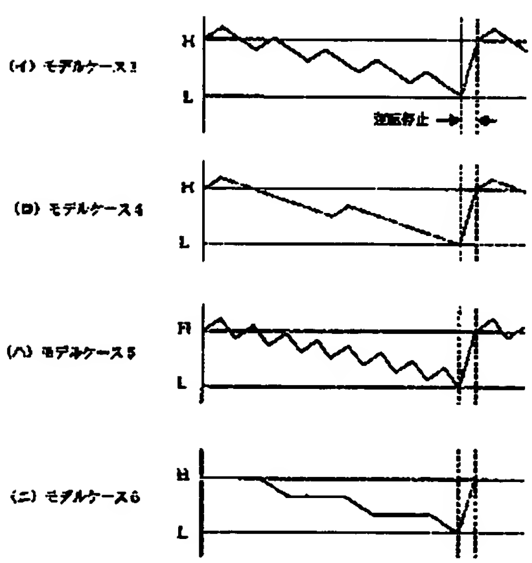
(ロ) モデルケース3



【図４】

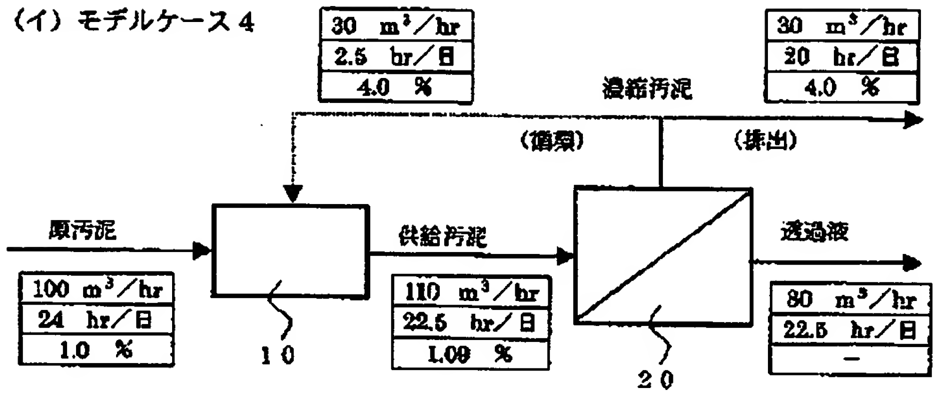

（イ）供給汚泥の流量
運転停止
（ロ）透過液の流量
（ハ）濃縮汚泥の流量
（ニ）濃縮汚泥の
汚泥濃度
4.1
3.9
（ホ）汚泥供給槽の
液面
H
L

【図６】

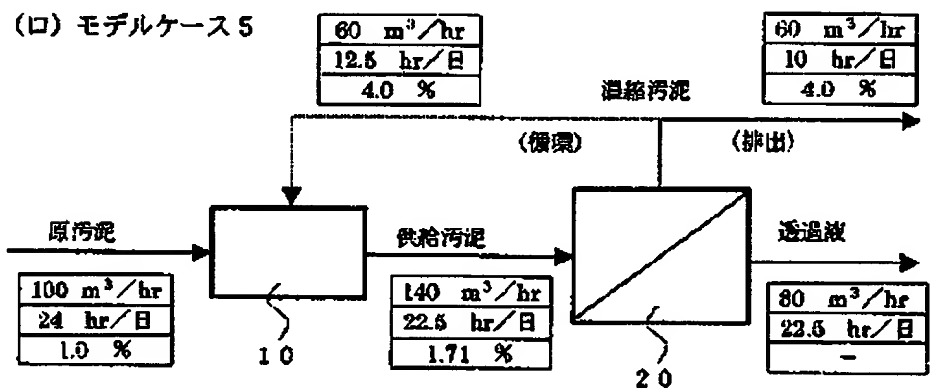

（イ）モデルケース３
H
L
運転停止
（ロ）モデルケース４
（ハ）モデルケース５
（ニ）モデルケース６

【図５】

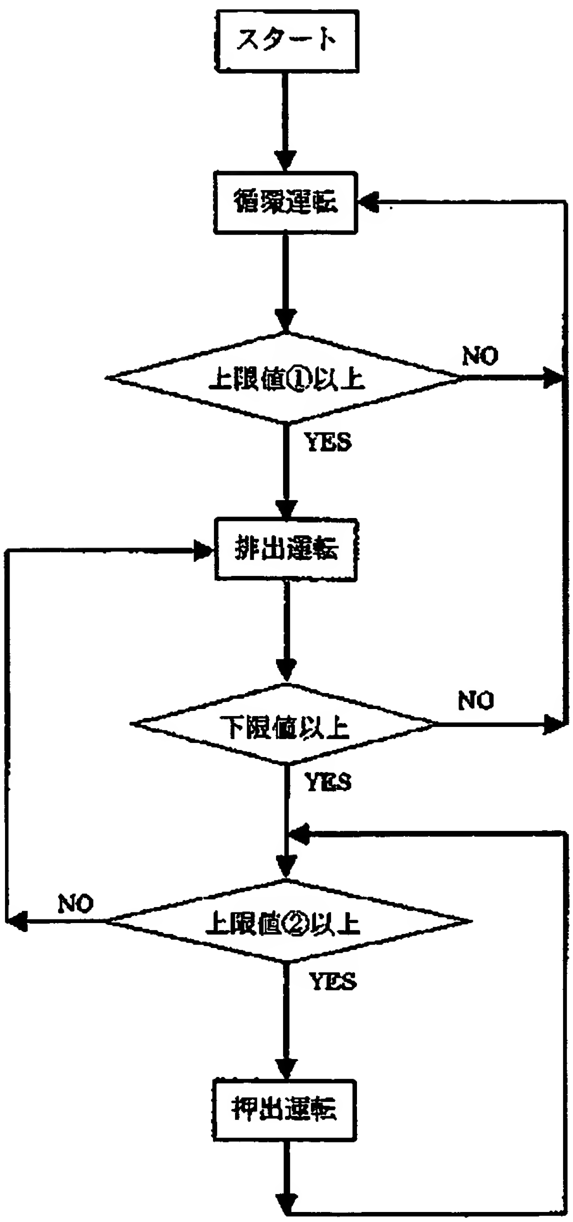
（イ）モデルケース４



（ロ）モデルケース５



【図９】



フロントページの続き

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PA02 PB14
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